

Procurement Decision Support for the Portuguese MoD: The MACBETH Approach and the Acquisition of 8x8 AWW¹

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ABSTRACT.

Since 2003, the Portuguese Ministry of Defense (MoD) has been using the MACBETH multicriteria approach in several evaluation processes for the acquisition of military equipment. This paper describes the first application case: the acquisition of 8x8 Armored Wheeled Vehicles to equip the Army and the Navy Marines, which contract was recently signed. This Tender was conducted by the National Armaments Directorate in cooperation with the Army and the Navy. The process last almost two years and involved: on a first stage, the revision and harmonization of the Services' requirements, and the issuing of the Tender Program and of the Technical Specifications; the process proceeded with the initial proposals' analysis, the performance of tests in Portugal and abroad, and the negotiation meetings; the final stage of the Tender comprehended the admission and evaluation of the Best and Final Offers, and finally the award of the contract to the globally most attractive proposal. Tender's Evaluation Regulation was based on the MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) methodology, previously adopted on large national and international tender procedures, that proved to be a flexible, consistent and robust decision support tool.

1. INTRODUCTION

The 8x8 Armored Wheeled Vehicles (AWV) acquisition program, for the Portuguese Army and Navy, whose tender phase was concluded on 2005, was a paradigmatic example of a successfully concluded joint military equipment acquisition program conducted by the Portuguese Ministry of Defense (MoD). Considering the high complexity of the process, one of key success factors was the introduction by the MoD of new methodologies to support the decision-making process of the Tender's Commission.

The genesis of the program is related with a capability gap analysis study performed considering the international commitments assumed by Portugal and the scenarios where the Portuguese Armed Forces might be operating. Based on this analysis it was set as a priority to equip the Army and the Navy Marines with AWV. Thus, by the end of 2002 the preliminary works for the launching of a competitive bidding for the acquisition of such vehicles began. The initial works regarding the definition of the operational requirements was carried by the Services' Staffs.

In order to ensure maximum competitiveness on the AWV acquisition program, a "public competitive bidding with selection of proposals for negotiation" was launched. This decision was taken by the Minister of Defense on July of 2003, marking the official start of the program. The conduction of the AWV acquisition program was assigned to the MoD's National Armaments Directorate (DGAED – see <http://www.mdn.gov.pt/mdn/pt/mdn/organograma/dgaed/>). This is the entity responsible, among others

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activities, for the supervision, coordination, control and execution of the Armed Forces equipment programs.

This paper presents a general overview of this acquisition process. Section 2 describes the phases of the bidding procedure. In Section 3, special emphasis will be given to the evaluation methodology, in particular regarding the application of the MACBETH approach (Measuring Attractiveness by the Categorical Based Evaluation Technique) (*cf.* Bana e Costa et al. 2003; Bana e Costa and Vansnick 1994). This was a socio-technical process that evolved throughout a sequence of decision conferences (Phillips and Bana e Costa, 2007) facilitated by the first author of this paper, under a contract signed between the MoD and IST (“Instituto Superior Técnico” – the engineering institute of the Technical University of Lisbon), with the second author acting as internal analyst and process coordinator.

2. PHASES OF THE COMPETITIVE BIDDING PROCEDURE

The AWW acquisition program involved the following phases, which are briefly presented ahead: a preparatory phase, the tender announcement, the proposal preparation and clarifications phase, the proposal selection phase, the negotiation phase, the contract awarding and the contract signature. The program timeline is synthesized in Figure 1.

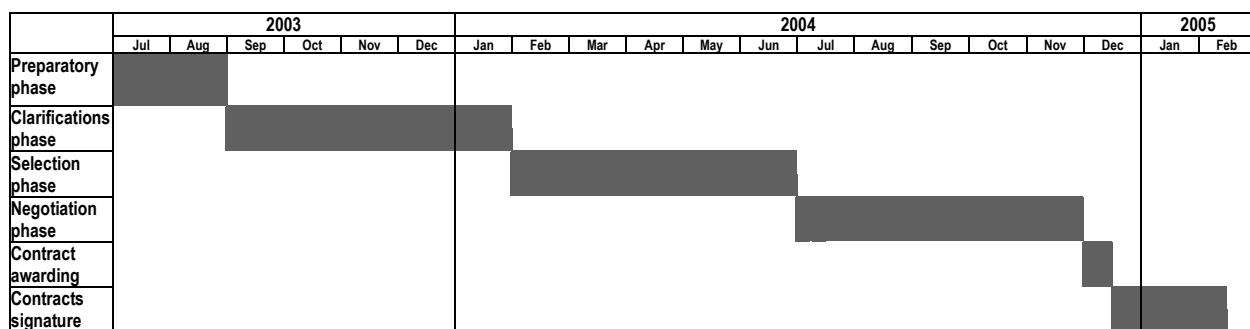


Figure 1 – Portuguese Army and Navy 8x8 AWW acquisition program timeline

Preparatory phase

The works regarding the 8x8 Armored Wheeled Vehicles Acquisition program, for the Army and the Navy, led by the DGAED, were initiated in July of 2003, with the review of the tender program and of the technical specifications proposed by the Services. The work was developed, since the beginning, by one joint Technical Team, that included representatives from the MoD, the Army, and the Navy, as well as civilian advisors and was headed by the second author of this paper. The activities of this team covered the technical, legal and financial issues. The works regarding Offsets were carried out by a specialized “Offsets Commission”, which worked in parallel with the technical, legal and financial teams. At the same time, an agreement was signed with IST, under which a MACBETH decision-analysis process consultation started in August 2003. The explicit choice of the MACBETH evaluation methodology by the MoD was justified by the success of its application in bid evaluation on large national and international public call for tenders (*cf.* Bana e Costa *et al.*, 2002). The methodology was presented and discussed at an initial meeting at the MoD, with emphasis on its alignment with the phases of the bidding procedure.

The main goal in the preparatory phase was the requirements validation, considering two basic principles:

- based on the knowledge about the market, the mandatory requirements could not restrain the number of solutions to one;

- the number of mandatory requirements should be minimal. The proposal selection based on desirable characteristics and on the key proposal features should be addressed by the evaluation methodology.

The Tender Commission, headed by the National Armaments Director, was empowered by the Minister of Defense and the approval of the final tender program documentation took place at the end of August. The tender was publicly announced in August 14, 2003. The tender documentation was made available to the potential bidders in September 1, 2003.

Proposal preparation and clarifications phase

September 1, 2003 marked the beginning of the first phase of the tender process, when the tender documentation was made available for consultation and acquisition by any potential tenderer. During this period the documentation was consulted by 6 companies and acquired by 4. In the subsequent months potential tenderers were provided with the requested clarifications. Meanwhile, the Proposals Evaluation Regulation was concluded and delivered to the potential tenderers. Section 3 is dedicated to an in-depth discussion of the aspects regarding the adopted evaluation methodology. Nevertheless, in summary it can be said that, during this phase, the works of the Technical Team consisted on the structuring activities leading to the identification of screening (rejection) criteria and evaluation criteria, the structuring of the latter in a value tree with several levels of specification, and their operationalization throughout the definition of reference performance levels (and value functions in a few cases) validated by the Tender Commission that, finally, could assign weights to the evaluation criteria.

Proposal Selection phase

The Proposal Selection phase was initiated with the opening of the Proposals, which took place on January 27, 2004. The end of subsequent analysis work happened when the Tender Commission issued the Preliminary Report on the Proposal Selection for the Negotiation Phase to the Minister of the Defense. This report was homologated on May 6, 2004. After a period of tenderers' hearings, the Final Report of the Proposal Selection Phase was homologated. The report admitted to the Negotiation phase 3 tenderers: Austrian Steyr-Daimler-Puch Spezialfahrzeug AG & Co KG, with vehicle PANDUR II; Swiss Mowag Motorwagen Fabrik AG, with the vehicle Piranha III C; and Finish Patria Vehicles OY, with vehicle AWW.

During the Selection Phase it was also prepared the Tests Plan for testing the vehicles in Portugal. This Plan defined the scenarios and the procedures for testing and verifying the vehicles and systems (about 60 different specific tests) and provided the test sheets to use on the tests. Tests included, for instance, the verification of the dimensional and functional characteristics of the vehicles, of ergonomic factors affecting crew and carried personnel, as well as tests on operational environment, both for terrestrial and amphibious configurations.

Negotiation phase

This phase was initiated with the submission of the proposed vehicles for performing the tests, which were designed to gather relevant information, namely regarding the mandatory requirements of the Technical Specifications and the technical requirements of the Evaluation Methodology. These tests were performed to the basic terrestrial and amphibious variants throughout a period of three weeks on July and August of 2004, in several Army, Navy and Air Force premises, involving not only military but also civilian experts on different fields of expertise. The content of each specific test was only disclosed to the tenderers at the beginning of the test, in a briefing presenting all the details regarding its execution, the involved means, the place where it was to be carried out, as well as the safety aspects to observe (see Figure 2).



Figure 2 – Tests performed in Portugal

On visits abroad it was possible to get acquainted with the capabilities of the potential subcontractors and with the characteristics of the main systems to install in the AWW, particularly the weapon systems.

The information gathered during the period of tests and with the visits and tests abroad, became decisive for the conduction of the negotiation meetings, which were carried out between September and October of 2004, and also for the bid evaluation using the evaluation methodology. The negotiations were done in several meetings with each of the tenderers, where the technical solutions and alternative proposals were discussed and analyzed in order to improve the global quality of the proposal. Resulting from these meetings some adjustments to the initial version of the Tender Specs (e.g., vehicle variants, quantities, and configuration requirements) were communicated to the tenderers, so that they could prepare their final offers.

Besides the technical negotiations, other negotiations meetings were done with the three tenderers for discussion of the Legal issues (aiming the agreement, in principle, of the wording of Contract minutes) and of Offsets (aiming the discussion of the Offsets programs).

In the beginning of November the tenderers received the directives for BAFO (Best And Final Offer), i.e., the procedural and formal rules regarding the elaboration, presentation and opening of the final version of the proposals. The public opening of the BAFO occurred in the November 11, 2004 on the day after the date set for the delivery of the proposals. Due to non-compliance with formal tender requirements the BAFO of Patria Vehicles OY was not accepted.

The proposals of the two remaining tenderers (hereafter designated by “S” of Steyr and “M” of Mowag) were analyzed by the Technical Team and compared with the reference performance levels defined on each criterion. This work informed the evaluation of the two proposals by the Tender Commission, according to the tender regulations. The evaluation activities were developed in decision conferences in which the M-MACBETH decision support system (Bana Consulting, 2005) facilitated the comparison and scoring of the proposals in the evaluation criteria. Subsequently, the Tender Commission delivered the Preliminary Report of the Negotiation Phase, which was approved by the Minister of Defense in December 1st, 2004. PANDUR II was the selected vehicle (see <http://www.army-guide.com/eng/product112.html>).

Contract awarding

After hearing the two tenderers, the Final Report of the Negotiation Phase was issued by the Tender Commission and submitted to the approval of the MoD. The Final Report homologation occurred on December 6th, and with it the Contract was awarded to the S tenderer. After the conclusion of the wording review, two contracts were signed on February 15, 2005. The Tender Contract regarded the acquisition of 240 terrestrial AWV for the Army, and 20 amphibious AWV, for the Navy. Table 1 presents some data about the variants that were contracted. A second contract was signed addressing the supply of spare parts for scheduled and unscheduled maintenance, regarding a 10 years period in the life cycle of each AWV.

Table 1 – Contracted AWV Variants

Variant	Terrestrial AWV (Army)	Amphibious AWV (Navy)
Infantry Carrier Vehicle	105	13
Infantry Carrier with RWS Vehicle	7	-
Command Post Vehicle	16	3
Mortar Carrier	31	2
Recovery Vehicle	7	-
Medical Evacuation Vehicle	10	-
Anti-tank Guided Missile Vehicle	15	2
Mobile 30 mm System Vehicle	30	
Reconnaissance Vehicle	4	-
Engineer Squad Vehicle	9	-
Armored Communications Vehicle	6	-
Mobile 105mm Cannon Vehicle	33 (optional)	-
Total AWV	240 + 33 (optional)	20

3. THE EVALUATION PROCESS

3.1 Overview of the Evaluation Methodology

The evaluation criteria and of the respective weights should be announced to the potential tenderers. This was a legal obligation according to Portuguese law and it is now clear in the recent Directive 2009/81/EC of the European Parliament and of the Council of 13 July 2009 (on the coordination of procedures for the award of certain works contracts, supply contracts and service contracts by contracting authorities or entities in the fields of defense and security): “it is therefore the responsibility of the contracting authorities/entities to indicate the criteria for the award of the contract and the relative weighting given to each of those criteria, in sufficient time for tenderers to be aware of them when preparing their tenders” (page L 216/85 § 70).

It is well-known in the Decision Analysis literature (*cf.* Belton and Stewart, 2002) that weights have no operational meaning without reference to a specific multicriteria aggregation procedure. The evaluation of the proposals of the competitive bidding for acquisition of the 8x8 AWV was done by developing, with MACBETH, a hierarchical additive aggregation model: value scores are (directly or indirectly) assigned to each proposal and multiplied by the respective weights previously assigned to the criteria and those products are summed across all of the criteria, at the different levels of the value tree, to determine the overall value score of each proposal. MACBETH requires only qualitative (non-numerical) judgments of difference in attractiveness (value) in order to help weighting the criteria and scoring the proposals (Bana e Costa and Chagas, 2004). The use of a non-numerical pairwise comparison value-elicitation procedure distinguishes MACBETH from the numerical-based multicriteria decision analysis procedures for bid evaluation surveyed in Bana e Costa *et al.* (2008).

Methodologically, the MACBETH model building process, used in the context of the acquisition program of 8x8 AWW for the Portuguese Army and the Navy, can be described as a package of activities of Structuring, Weighting, Scoring and Recommending, developed during working sessions of the Technical Team and decision conferences with the Tender Commission, as presented with more detail hereafter.

3.2 Definition of the Evaluation Regulation

The Evaluation Regulation should include the screening and evaluation criteria, the reference performance levels on the evaluation criteria and their relative weights. A few value functions were also defined.

First structuring activity: defining screening criteria and evaluation criteria

For the 8x8 AWW Acquisition program it was assumed that all the 243 requirements defined on the Technical specifications of the Tender were mandatory. In this way, the screening or rejection criteria coincided with the mandatory requirements (also referred as the essential requirements of the 12 AWW variants).

As remarked by Bana e Costa *et al.* (2008) the evaluation criteria should be carefully selected; no additional criteria can legally be added after the bids are submitted. Moreover, since proposals will be compared and scored in terms of their relative attractiveness with respect to each criterion individually, each criterion must be an independent evaluation axis. This is the reason why several characteristics are often clustered into a single criterion rather than analyzed as independent criteria. The set of criteria should be consensual, and therefore exhaustive, but also concise and non-redundant. In addition, each criterion should be specific and understandable and operational for the appraisal of bid performances.

The definition of the evaluation criteria started by identifying the requirements defined in the Technical Specifications that are deemed as deserving a specific evaluation, and other characteristics that, despite not being of mandatory inclusion in the offers, would introduce some degree of differentiation in the quality of the proposals. The identification of the criteria and the respective logical structuring in a value tree format (see Figure 3) was validated in a decision conference with a Tender Commission, supported by previous work by the Technical Team.

The value tree integrates three levels of evaluation criteria – criteria, sub-criteria and sub-sub-criteria – that were weighted and on which proposals should be scored. Four top-level criteria appear immediately after the root node: ‘Aspects regarding Costs’, ‘Aspects regarding Offsets’, ‘Aspects regarding Delivery Schedule’ and ‘Aspects regarding Technical Requirements’. The first and third criteria have no children criteria; but there are 13 sub-criteria specifying the Delivery Schedule criterion, each one corresponding with a specific AWW mission objective. The structure of the tree under the Requirements criterion node is more complex, with three sub-criteria of ‘Operational’, ‘Technical (generic)’ and ‘Logistical’ Requirements, each one in turn parent of several sub-sub-criteria. Each of these sub-sub-criterion is a group of several more elementary requirements. These are intertwined characteristics that cannot be defined as isolated evaluation criteria. For example, the AWW value tree in zoomed in Figure 3 to show the 7 sub-sub-criteria that specify the ‘Operational Requirements’ and the 4 characteristics of the ‘AWW Combat System’ defined at two-lower levels. It is important to emphasize that the characteristics are not independent evaluation criteria and therefore they cannot be weighted nor can the proposals be scored separately on each of them.

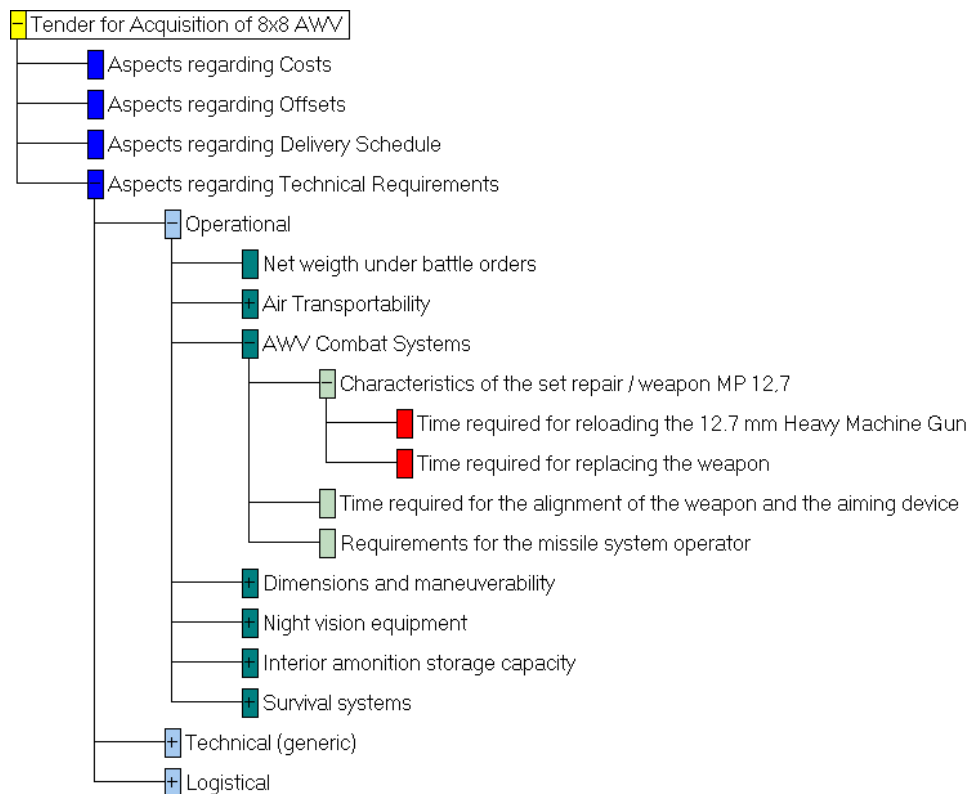


Figure 3 – Partial view of the AWV value tree.

Second structuring activity: Defining reference performance levels

Two reference performance levels of intrinsic value (‘were defined on each evaluation criterion. They convey and make operational the concept of neutral proposal (i.e., neither attractive nor repulsive) and of good proposal. The identification of the levels Good and Neutral:

- contributed to increase the intelligibility of the criteria;
- made possible to define the notion of intrinsic attractiveness of each proposal (in order to be categorized as very positive, positive or negative); and
- allowed to use a criteria weighting procedure, simultaneously adjusted to the specific characteristics of the competitive bidding and valid regarding the theoretical framework of additive value aggregation.

The reference levels were defined from bottom to up in the value tree. For example, Table 2 shows the ‘Good’ and ‘Neutral’ performances for each of the four characteristics of the ‘AWV Combat Systems’. Moving up one level in the tree, a Good (or Neutral) ‘AWV Combat Systems’ would be one with good (or neutral) performances in all the 4 characteristics (or another profile as attractive as this one). Multidimensional reference levels were defined in a similar way for all other sub-sub-criteria that are defined upon characteristics. And so on along the tree. Figure 4 shows the reference levels for the 4 evaluation criteria.

Table 2 – Example of the reference performance levels for the sub-sub-criterion ‘AWV Combat Systems’

Characteristics	GOOD	NEUTRAL
Time required for reloading the 12.7 mm Heavy Machine Gun	Time required for reloading operations equals 2 minutes	Time required for reloading operations equals 5 minutes
Time required for replacing the weapon (12.7 mm Heavy Machine Gun and 40 mm Automatic Grenade Launcher)	Time required for replacing operations equals 5 minutes (for the same type of weapons or for different types of weapons)	Time required for replacing operations equals 15 minutes (for the same type of weapons or for different types of weapons)
Time required for the alignment of the weapon and the aiming device	Time required for alignment operations equals 5 minutes	Time required for alignment operations equals 10 minutes
Requirements for the missile system operator regarding the possibility of system operation by personnel that needs, or not, vision correction glasses	The system can be operated by personnel that needs vision correction glasses	The system can only be operated by personnel that doesn't need vision correction glasses

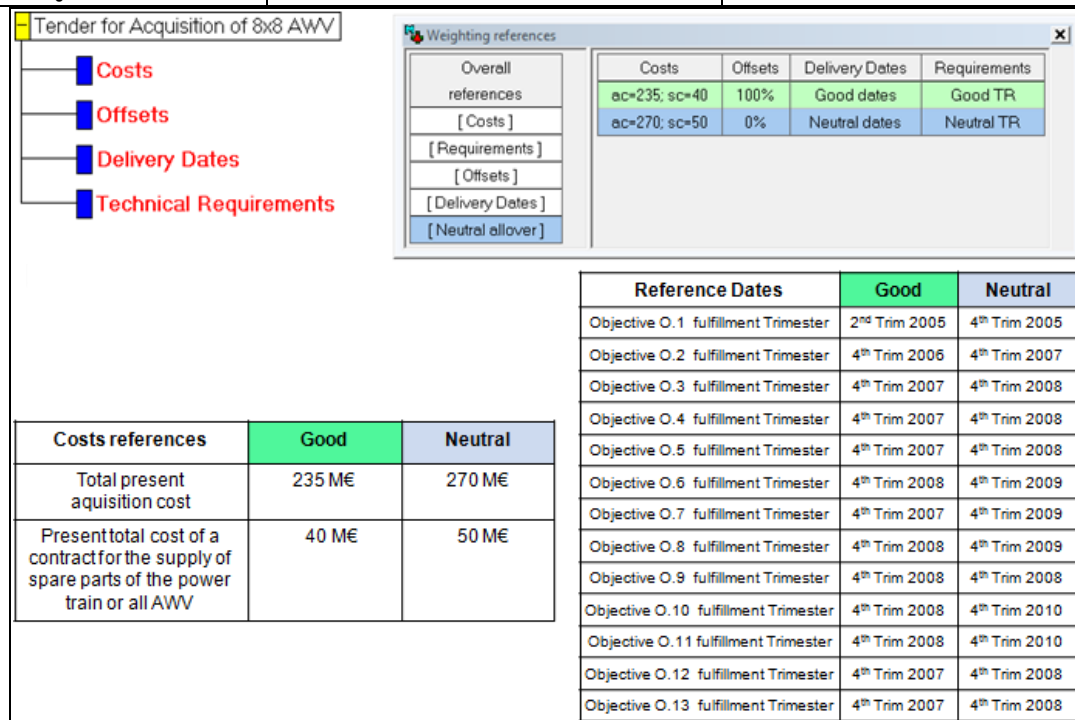


Figure 4 – Performance reference at the top-level of the value tree.

Of course, reference levels were directly specified for those sub-sub-criteria or sub-criteria or criteria that have no children. This is the less complex situation. On the other hand, when the degree of complexity is very high due to the presence of a significant number of intertwined characteristics, the definition of the reference levels can be facilitated by adopting the “determinants technique” proposed by Bana e Costa *et al.* (2002).

On the defined Evaluation Methodology, in each evaluation criterion, the Neutral level corresponded to a 0 (zero) score and the Good level to a 100 (one hundred) score.

The weighting activity

The process of weighting the evaluation criteria was developed in a hierarchical way, in decision conferences with the support of the M-MACBETH software. This enabled to construct an additive value model of type (1) to aggregate the scores $v_j(b)$ of each bid b in the $n=4$ criteria ($j = 1, \dots, n$) and calculate its overall score $V(b)$.

$$V(b) = \sum_{j=1}^n k_j \cdot v_j(b) \quad \text{with} \quad \sum_{j=1}^n k_j = 1 \quad \text{and} \quad k_j > 0 \quad \text{and} \quad \begin{cases} v_j(\text{good}_j) = 100 \\ v_j(\text{neutral}_j) = 0 \end{cases} \quad (1)$$

The reference performance levels in each criterion j are designated by good_j and neutral_j . They allow to determine the scaling factors k_j – commonly known as “weighting coefficients” or relative “weights” – that in turn allow value units on different criteria to be transformed into overall value units, through some form of operationalizing the notion of value trade-off: how much the Tender Commission considers necessary to improve the performance in one criterion to compensate a decrease of performance on another criterion.

Let us detail the MACBETH weighting process that took place at the top-level of the four valuation criteria. Firstly, to order the criteria weights, it was sufficient to ask the Tender Commission: “Consider a hypothetical proposal (N), with neutral performances in all criteria. If it were possible to improve the performance of N from neutral to good in only one criterion, maintaining all of the others at their neutral level, for which criterion would this swing be most attractive? And the next most attractive?” Repeating this question until no criteria are left, led directly to the order of importance of the swings and consequently, by model (1), to the order of the criteria weights. The evaluation criteria were therefore presented to the potential tenderers already in decreasing order of their relative weights:

- 1st Aspects regarding **Costs**;
- 2nd Aspects regarding **Technical Requirements**;
- 3rd Aspects regarding **Offsets**;
- 4th Aspects regarding **Delivery Schedule**.

Next, to estimate numerical values for the criteria weights with MACBETH, the Tender Commission started by making qualitative judgments about the relative importance of each one of the four swings from neutral to good. The judgements are expressed by choosing one of the MACBETH semantic categories (“very weak”, “weak”, “moderate”, “strong”, “very strong”, or “extreme” difference of attractiveness). Each judgement should reflect a collective view of increased overall attractiveness, and therefore judgmental disagreement or hesitation between two or more consecutive categories is allowed. The judgements were introduced in the last column of the MACBETH weighting judgments shown in Figure 5. Then, the Tender Commission was asked to fill in the rest of the matrix (if two criteria have the same weight, “no” is introduced in the matrix) by qualitatively judging, for each pair of criteria j and j' with $k_j > k_{j'}$, the difference of overall attractiveness between swinging from neutral to good in j instead of swinging from neutral to good in j' – that is, judging the difference of overall attractiveness between the hypothetical proposals b_j (good in j and neutral in the other criteria) and $b_{j'}$ (good in j' and neutral in the other criteria). Each time a judgement was introduced into the matrix, the software automatically tested the consistency of all the judgments thereto made and offered suggestions to resolve inconsistencies when they arose. For the consistency matrix of judgments in Figure 4, MACBETH suggested numerical values for the weights, which were subsequently validated and adjusted by the Tender Commission within ranges compatible with the judgments elicited. The bar chart in Figure 5 shows the relative weighing (in percentages) finally defined for the four evaluation criteria.

In the case of the criterion “Aspects regarding Technical requirements”, this procedure was applied firstly for each group of sub-sub-criteria sharing the same parent sub-criterion, then for the group of seven sub-criteria.

The result of this work was used in the evaluation regulation, which constituted the Annex I to the Tender Program. This document described the Evaluation Methodology and listed the criteria, sub-criteria and sub-sub-criteria, as well as their relative weighting. For each relevant area the regulation also defined the characteristics to consider in the evaluation, as well as all of the reference good and neutral performances levels defined.

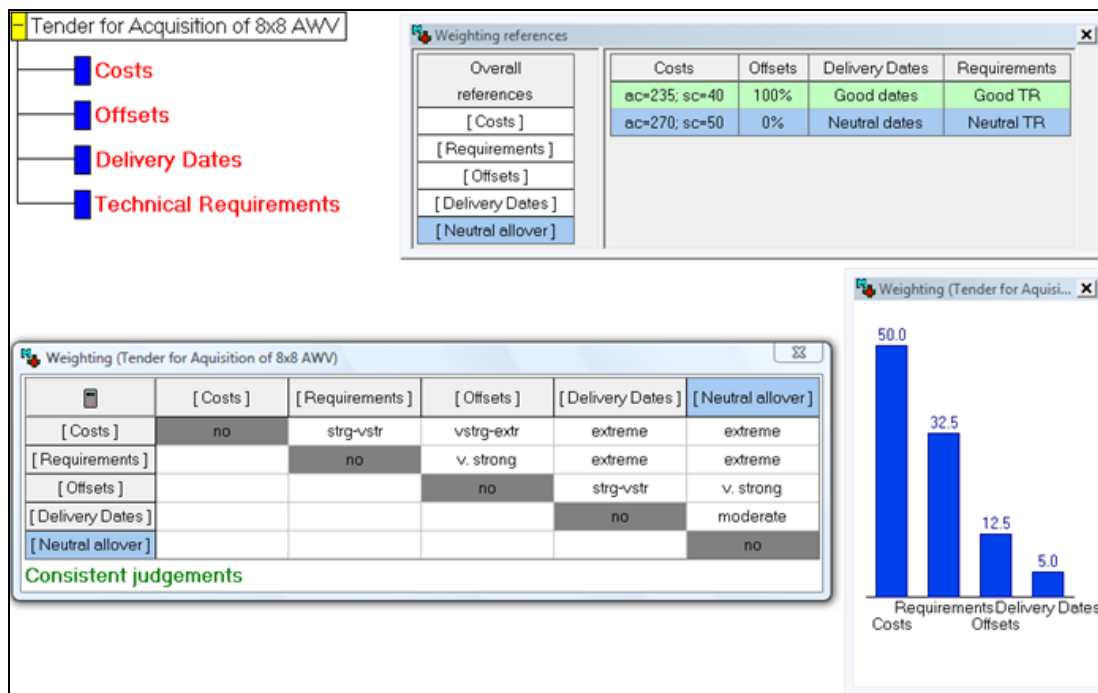


Figure 5 – Using the M-MACBETH software in weighting the four top-level criteria.

3.3 Analysis and Evaluation Activities: Scoring the Proposals

After the reception of the final proposals and the respective formal analysis, the evaluation process was initiated with the verification of the fulfillment of the mandatory requirements (rejection criteria). Passed this phase, the evaluation of the proposals was conducted taking in account the established evaluation criteria. For this purpose, data regarding each of the characteristics defined in the evaluation regulation was compiled. The work progressed in decision conferences of the Tender Commission, for assessing, firstly, each proposal performance in relation to the reference performances Good and Neutral defined in the evaluation regulation. The proposals were then evaluated qualitatively regarding their attractiveness with respect to each criterional group of intertwined characteristics - typically a sub-sub-criterion.

Figure 6 illustrates a graph used to support the evaluation of the proposals on a “Technical Requirements” sub-sub-criterion with ten different characteristics (I to X). The graph contains two broken-lines, defining the profiles resulting from the analysis of the two proposals on each characteristic. Each vertical line refers to one characteristic, with three zones of intrinsic attractiveness: “negative proposal” (if worse than Neutral), “positive proposal” (if better than or indifferent to Neutral and worse than Good) and “very positive proposal” (if better or indifferent to Good). Note in Figure 6 that the positioning of a proposal within a zone admits several nuances as, for instances, the qualification “below Neutral” in the negative zone, or the differentiation between “above Neutral” and “close to Good” in the positive zone.

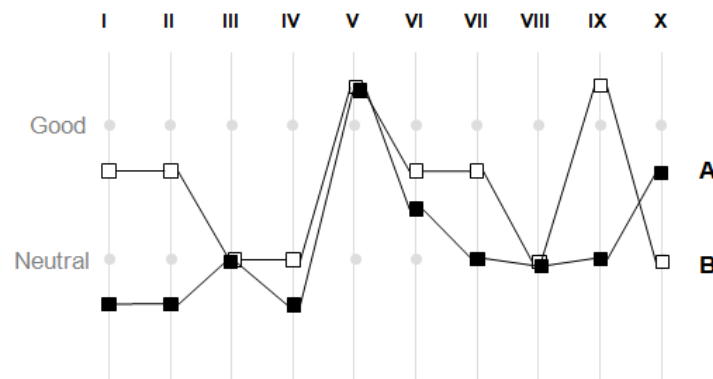


Figure 6 – Example of a support graph used for comparing the proposals on an evaluation criterion with multiple characteristics.

Based on the analyses done for the characteristics of a sub-sub-criterion, the Tender Commission pairwise compared the proposals and the two reference levels, making MACBETH judgments at the level of the sub-sub-criterion. Thus, for each sub-sub-criterion (or for each criterion or sub-criterion with no children criterion) a matrix of qualitative MACBETH judgments was filled, the consistency of the judgments was verified and scores were assigned to the proposals, as illustrated in Figure 7.

Illustrative sub-sub-criterion					
	Good	Proposal A	Proposal B	Neutral	Current scale
Good	no	weak	v. strong	v. strong	100
Proposal A		no	strong	v. strong	78
Proposal B			no	moderate	33
Neutral				no	0
Consistent judgements					

Figure 7 – Example of a MACBETH evaluation of proposals.

The application of model (1) to the scores of each proposal on the sub-sub-criteria of each of the three Requirements sub-criteria, taking in account the relative weights of the respective sub-sub-criteria, resulted in three aggregated scores for each proposal on each one of those three sub-criteria. Finally, applying again model (1) for the three aggregated scores, taking into account the relative weights of the three sub-criteria, enable to calculate the overall score of each proposal on the “Technical Requirements” criterion.

A consistent MACBETH matrix of judgments of difference in attractiveness on the criterion ‘Aspects regarding Costs’ enabled the scoring of the proposals on this criterion. In what concerns the ‘Aspects regarding Offsets’ criterion the scores of the proposals were calculated by a linear value functions defined upon ‘Offsets scores’ calculated by the “Offsets Commission” using a specific model establish by law. Also, value functions defined for the 13 sub-criteria of ‘Delivery Schedule’ criterion enabled to score the options at this sub-level and then model (1) was applied to calculate proposals’ scores on ‘Delivery Schedule’. Of course, the value functions were defined in the Evaluation Regulation.

Finally, the application of model (1) to the scores of each proposal on the four top-level evaluation criteria, taking in account the respective weights, resulted in the global score of each proposal, as shown in Figure 8. This Figure shows that the difference between the global scores of the two proposals was about 10 overall value units, that is, about 10% of the scoring difference between a Good hypothetical proposal and a Neutral hypothetical proposal.

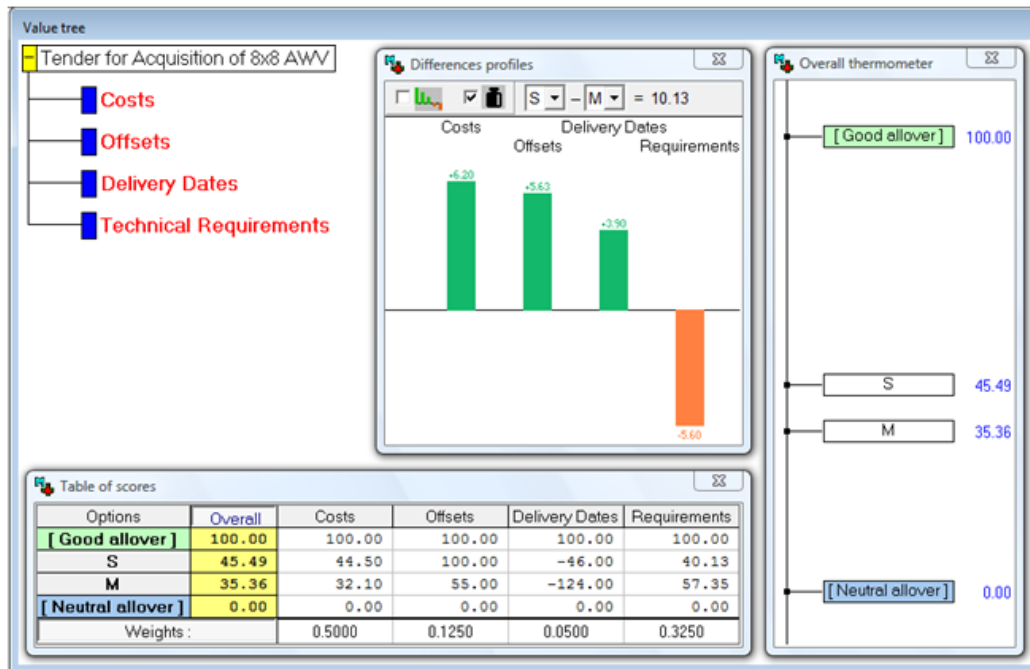


Figure 8 – Calculating the global scores of the proposals.

3.4 Validation and the Recommendation Activities

At the end, the results were validated by analyzing their sensitivity and robustness to variations in several parameters of the evaluation model constructed. For instances, it was analyzed the effect in the global ranking of the Proposals of changing the relative weight of the Requirements criterion, since this was the only criterion where the Tenderer with the less attractive proposal presented a more attractive evaluation. The conclusion of the analysis was that the most attractive proposal would only loose its first place if the weighting coefficient of the factor “Aspects regarding Technical requirements” would become larger than 57.5% (see Figure 9).

All considered, it was possible to confirm that the choice of best proposal based on the judgments issued by the Tender Commission and from the application of the evaluation methodology was a robust decision. Thus, the Commission wrote the Preliminary Report of the Negotiations Phase that, after the ministerial homologation and a period of Tenderers Hearing, resulted in the Final Report of the Negotiations Phase. With the homologation of the Final Report, the Tender was adjudicated to the Tenderer that presented the globally more attractive proposal.

Still regarding the Evaluation Methodology, the criterion “Aspects regarding Costs” included the cost of a contract for the supply of spare parts of the power train for all AWW. The terms and the conditions for such contract were defined, *ab initio*, in the Tender Program. The Portuguese State reserved the right to sign a contract based on such proposed conditions. Since the conditions submitted by the Tenderer who presented the best global proposal were considered advantageous for the State, the final decision was to sign a second Contract for the Supply of Spare Parts for the AWW, covering a 10 years period of the life of each vehicle.

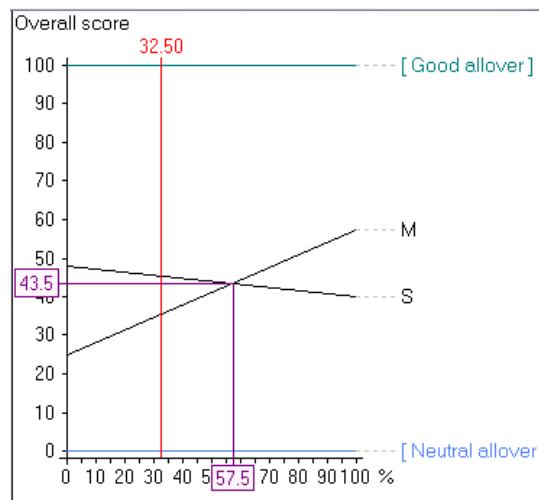


Figure 9 – Weighting sensitivity analysis on Requirements.

4. CONCLUSION

The legislation forces public tenders for acquisition of goods and services to include an evaluation regulation that guarantees the rigor and transparency of the decision making process. However, no specific methodologies of evaluation are imposed. In the process regarding the Program of Acquisition of 8x8 AWV for the Army and the Navy, it was adopted the MACBETH approach, which is characterized by a participatory group decision making process, based on the analysis of the attractiveness of the proposals submitted by the tenderers. Thus being, the application of this approach compels the decision makers to become actively involved in the evaluation of all the relevant characteristics of the proposal, through discussion sessions intended to the judgment of the proposals. This socio-technical process favors the raise of awareness about the implications of each option. This approach also offers methodological consistency and means to assess the robustness of the results. In fact, the MACBETH methodology has been adopted, at national and international level, in several large Public Tenders.

It is noteworthy that, through this logistic process, it was successfully concluded the award of a major joint program intended to equip the Portuguese Armed Forces, which dealt not only with the problem of acquisition of equipment, but also with the problem of their support over a significant part of life cycle.

After this Tender some other Defense Tenders have been conducted or prepared at the MoD using the MACBETH approach to support the definition of the Evaluation Regulation and of the decision-making process.

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